CHAPTER 24

REVISIONAL LATERAL ANKLE RECONSTRUCTION WITH THE USE OF FREE TENDON AUTOGRAFTS

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INTRODUCTION

Instability of the lateral ankle is one of the most frequently-encountered challenges facing foot and ankle surgeons. This entity accounts for nearly 40% of all sporting injuries and is commonly seen in both active and non-active patient populations (1). While the majority of cases are responsive to conservative measures, nearly 20% of individuals will progress to chronic instability, which if left untreated can further progress to degenerative changes within the ankle joint due to unbalanced loading (1). At least 50 stabilization procedures have been reported in the literature with a wide variety of techniques, indications, and materials (2). More recently, multiple authors have come to advocate for anatomical repairs; utilizing both the direct repair of weakened ligaments as well as the use of autologous and allogeneic tendon grafts (1-7).

Not every procedure is ultimately successful, and occasionally patients with residual symptoms will require additional stabilization. Revisional surgery under any circumstance carries its own inherent complicating factors. These may include the formation of scar tissue as well as the attenuation or absence of native structures due to prior intervention. The purpose of this update is to define the role of autologous free tendon grafts in revising the previously-reconstructed lateral ankle. Additional principles and techniques to maximize outcomes will also be discussed.

PREOPERATIVE ASSESSMENT

Regardless of whether primary or revisional surgery is to be performed, several considerations must be addressed in the work-up. The first is the presence of ankle versus subtalar (or combined) instability. This question is actually a source of great debate among authors with huge ramifications regarding which procedure can justifiably be chosen.

Traditionally, advocates of the classic tenodesis procedures sought to stabilize the entire lateral complex as a means to prevent persistent hindfoot laxity. Early critics of these techniques focused on their propensity to limit subtalar inversion as originally reported by Evans (1954) and Elmslie (1934). Thus, some surgeons have promoted an isolated repair of the ATFL alone; via either direct repair or with free tendon grafting (5,7,8). Indeed Krips et al reported a higher reoperation rate, increased laxity, pain, arthritis, and limited dorsiflexion in a subset of patients receiving an Evans tenodesis compared with anatomical repair at a 20-year follow-up (9). Alternatively, some recent reports have highlighted the frequency of combined ligament insufficiency and emphasize the importance of double-ligament repair (2,7). Patterson and colleagues indicated an increase in subtalar joint laxity in several of their patients who had received an isolated ATFL augmentation with a semi-tendinosis graft (7).

Clearly, the presence of subtalar joint instability should be determined preoperatively. This can be facilitated via several modalities in addition to a standard clinical examination. Stress radiography should evaluate the anterior drawer and talar tilt associated with the ankle. On the same views, abnormal supination of the tri-tarsal complex as well as anterior, posterior, and medial displacement of the calcaneus on the talus will be noted when subtalar instability is present (4). Magnetic resonance image (MRI) findings can also help to indicate damage to the associated stabilizing structures, i.e., the CFL, interosseous talocalcaneal ligament, cervical ligament, and peroneal tendons. Other authors have advocated preoperative continuous varus stress testing using C-arm under anesthesia (2,10). One criteria proposed has been the ability of the heel to invert greater than 30 degrees with the ankle locked within the mortise on fluoroscopy (2,11).

Another important consideration in the preoperative evaluation is the presence of a hindfoot varus. In these patients, a calcaneal osteotomy is warranted. Kuhn and Lippert reported on 15 revisional lateral ankle reconstructions using the Broström-Gould technique with excellent results achieved in 12 patients. For their report, a hindfoot varus was determined by a dynamic ankle rollout on gait examination defined by a lateral thrust between heel strike and flatfoot weightbearing. These individuals received valgus calcaneal osteotomies in addition to ligamentous reconstruction, however, their outcomes were not specifically reported (5). Regardless, it can only be inferred that failure to address the structural component will certainly contribute to residual pain and deformity.

One of the most obvious factors to consider when evaluating a previously-repaired lateral ankle is the original procedure. This will help determine which structures are available for harvest and augmentation if necessary. MRI is again very helpful in this regard, especially in patients with incomplete histories. Surgical planning should be focused on the presence and structural integrity of the ligaments and tendons surrounding the lateral ankle.

With regards to direct repair, some authors argue that there is usually inadequate capsular tissue for reefing, while others have suggested that available scar tissue can be a useful adjuvant to augment stabilization (2,5,12,13). These judgments can be reserved for the operating room, but the intraoperative presence and quantity of scar tissue formation should also be correlated with the patient's pre-operative clinical symptoms.

We feel that individuals requiring revisional ankle repairs may be best served by using autologous tendon supplementation for improved stability and function. Certainly, techniques using a partially separated split peroneus brevis have been presented with good results (12). Other authors have advocated against this approach, arguing that the peroneus brevis is a major dynamic stabilizer of the lateral hindfoot (1,3,4,10). Regardless of the technique chosen, it seems to be well-accepted that the more anatomic the reconstruction, at least theoretically, the better the outcomes (1,2,3-6,10). As stated by Chan et al regarding such repairs (1), "…by increasing the anatomicity of the reconstruction, the tenodesis can be improved."

TENDON GRAFT OPTIONS

Burrows was the first author to advocate the use of a free tendon graft to reconstruct the ATFL in 1955 (8). Since that time, a wide variety of options have been proposed including the gracilis, semitendinosus, fascia lata, palmaris, plantaris, and patellar tendons among others (1). It is interesting to note the perceived as well as empiric evidence in support of autograft versus allogeneic transfer candidates. Horibe et al presented what is perhaps the last significant publication in 1991 utilizing digital flexor and extensor tendons from fresh cadaver limbs to reconstruct weakened ATFL and CFL tendons. They reported no infections or immunologic reactions with modest results in 13 ankles (14). More recently, Scheffler and colleagues demonstrated delayed remodeling with reduced stability and mechanical function using allografts versus autografts in 48 sheep models using long flexor tendons for ACL reconstructions (15). It can reasonably be presumed that autograft transfers are preferable, and thankfully, many options are available.

Hamstring grafting options have been proposed by several authors in the orthopedic community in recent years, advocating use of the free gracilis or semitendinosus tendons (2,6,7). Proponents of these techniques argue that they can provide an anatomical reconstruction without compromising peroneal function or motion at the ankle or subtalar joints. It has been cited that roughly 12-16 cm of gracilis tendon can be routinely harvested, and another technique utilized an oblique fibular drill hole oriented precisely to the angle of the ATFL (2,6). This would appear to offer promise in terms of a near-anatomical reconstruction. On the other hand, concerns have been referenced regarding donor site morbidity associated with these grafting techniques. In referencing ACL repairs, Yasuda and colleagues noted that hamstring muscle strength was decreased for at least 9 months following harvest of the semitendinosus or gracilis tendons (16). This finding was also noted by Marder et al (17). As recently as 2001, Kartus and associates concluded that (18), "There is a lack of knowledge about the course of the donor site after harvesting hamstring, fascia lata, and quadriceps tendon autografts."

Another grafting option referenced in some of the older literature is the use of the plantaris tendon. Sefton and colleagues used this tendon to repair strictly the ATFL and reported satisfactory outcomes in 18 patients (8). Anderson later reported on his technique, which involved release at the myotendinous junction through a small incision on the proximal-medial leg while leaving the calcaneal insertion intact (19). Specific concerns arise regarding this transfer option. First is the question of tendon availability. The plantaris is missing in approximately 6% of the general population, thus warranting a preoperative MRI evaluation for surgical planning. Saxena and Bareither demonstrated a 92% sensitivity and 100% specificity when correlating MRI findings to cadaver specimens (20). They noted that the tendon can more easily be identified when axial sections are limited to 4 mm or less. Even then, as noted by these authors and others, the plantaris may often be too small for grafting purposes (20-22).

Several less-common free transfer options also exist, and may serve as viable alternatives. The peroneus quartus is a supernumerary muscle of the lateral compartment, which has been described with variable anatomic presentations in roughly 10-22% of observed cases (23). Limited case reports have actually described its utility in revisional lateral ankle stabilization (24). Unfortunately, its limited presence may preclude many surgeons from routinely choosing this as a repair option. Another alternative described in some reports has been the use of the digital tendon slips (14,25). Takahashi and colleagues reviewed 13 ankles, which had undergone arthrocopy followed by lateral stabilization using an extensor digitorum longus as a pedicle graft. Their technique involved subcutaneous extraction of the tendon from the second or third toe using a tendon-stripper through a small incision at the metatarsophalangeal joint. The ATFL and/or CFL were then repaired as necessary in a figure-8 fashion. At 7-year follow-up, the authors indicated pain in only one patient without chondral injury. They also indicated that digital function is preserved as the distal EDL slip is sutured to the EDB tendon (25).

At our facility, we have had some experience lately with the use of a free split peroneus longus tendon graft in several cases of revisional lateral ankle stabilization. This technique has recently been highlighted by Peterson and colleagues in conjunction with a Broström-Gould procedure for combined ankle and subtalar joint instability (4). A similar approach has also been previously-referenced (26). We believe this technique offers several advantages in providing a near anatomic reconstruction while preserving the peroneus brevis tendon and sacrificing only half of the peroneus longus. It is also relatively easy to perform, without having to open other compartments, and prevents excessive donor site morbidity.

ADDITIONAL CONSIDERATIONS

Once the determination is made regarding the procedure, technique, and graft options necessary to revise a lateral ankle, several additional factors should be considered. The distinction between functional and mechanical instability should be made preoperatively, and some surgeons recommend a preoperative rehabilitation program of peroneal strengthening and proprioceptive training (2).

An important point to decide on is the mechanism of tendon fixation. Multiple choices are available for this purpose, but two of the most common subcategories are bone anchors and interference screws. Jeys and associates published a comprehensive review in 2004 evaluating the associated pull-out strengths and elongation using both techniques. They used procine talus models with loads applied at 70 degrees to simulate angular pull of the ATFL in 36 specimens. The authors found the interference screws to exhibit significantly higher pull-out strengths as well as less elongation upon applications of physiologic stress when compared to the bone anchors (3). For this reason, and based on our experience, we favor the use of interference screws for tenodesis procedures of the lateral ankle. We have found them to generally be easy to insert with greater apposition and stability as compared to tendon anchors, trephine plugs, or other methods.

A final pertinent question, especially with regard to revisional surgery, is whether to supplement the repair with additional biologic agents to enhance healing and minimize scar tissue formation postoperatively. This is generally recommended, though it is certainly left to the discretion of the surgeon and patient specifics. It has been reported that repair of tendon ruptures can be stimulated by a single application of one of several growth factors such as PDGF, TFG-β, IGF-1, VEGF, GDG-5,-6,-7, and thrombocyte concentrate (27). We have chosen to augment several of our revisional repairs with platelet-rich plasma and/or amniotic membrane grafts. These agents provide many of the relevant growth factors, and (in the case of amniotic membrane) various types of collagen and other specialized proteins. These products offer a tremendous advantage in promoting organized healing following revisional ankle surgery.

CASE 1

This individual was a 26 year-old male who presented to the clinic with chronic pain and instability to his right ankle. The patient related that approximately three years earlier he had been running with a 150-lb pack while on active duty in the military when he felt his right ankle “snap.” He was treated with conservative measures unsuccessfully until roughly a year later when he underwent a Broström-Gould procedure performed elsewhere. According to the patient, this procedure provided a short period of improved stability and pain relief, however, his symptoms eventually returned. Over the subsequent two years following the original stabilization, the patient experienced a deterioration in his symptoms, and he was not responsive to icing, bracing, physical therapy, or a series of multiple injections. Eventually the patient, who earnestly wanted to continue working, was forced to quit his job as an electrician and seek disability assistance.

Clinical examination revealed significant pain to palpation to the anterior-lateral ankle with severe guarding. Upon administration of a local ankle block for stress views, the patient demonstrated a positive anterior drawer sign to the right ankle. A preoperative MRI was also performed in which the previous repair to the ATFL ligament could not be identified (Figure 1). Thus, the decision was made to bring the patient back to the operating room to perform a revisional stabilization augmented with biologic agents supplementation.

The procedure began with an anterior lateral incision with dissection continued down to the level of the capsule, which was incised to expose a mostly-intact but severely-attenuated ATFL. Please see suture incisions, figure 13, which protray incisions used. The ligament was transected perpendicular to its long axis to prepare for later imbrication. Several strands of previously-utilized suture were noted within the substance of the tendon, which were removed (Figure 2). The lateral subtalar joint was also inspected and taken through a full range of motion with no pathologic changes noted. At this time, the decision was made to augment the repair with a free split peroneus longus tendon graft.

Attention was next directed posteriorly to the lateral aspect of the calcaneus. In this location, a piece of umbilical tape was used for incision planning, and to determine the appropriate length of tendon graft required. This was accomplished by selecting approximate locations on the lateral aspect of the posterior calcaneal wall, as well as on the lateral talar neck, and marking out the appropriate amount of tape length (Figure 3). This length of tape was then extended from the location of the posterior calcaneal wall, posterior to the course of the peroneal tendons, and extended proximally at the lateral course of the fibula. This site, as well as the other site indicated, was marked out utilizing a skin marker (Figure 4).

Two small incisions were then created in the locations indicated by the skin marker, which were both deepened until the peroneus longus tendon could be identified within each incision. The tendon was identified when plantarflexion of the first ray was noted upon light tensioning with a Senn retractor. Umbilical tape was then used to isolate the tendon near its myotendinous junction, and a #15 blade was used to incise the tendon through its central portion. At this point, the tape was routed through the mid-substance of the tendon to prepare for harvesting (Figure 5).

Next, a tendon passer was introduced through the distal incision into the peroneal compartment and directed towards the proximal incision where the ends of the umbilical tape were grasped (Figure 6). The tendon passer was then withdrawn to expose the tape ends distally. At this point, the umbilical tape was used in a Gigli saw maneuver to sever the PL tendon longitudinally, and the tendon was then transected from its central portion posteriorly at both the proximal and distal incisions to complete release of the tendon segment (Figure 7).

Attention was then directed to the lateral talar neck and lateral calcaneal wall where a guidewire was used in each location. The wire serves as a guide to drill an anchor slot for planned placement of the interference screws. A bone trephine was then utilized to bore a hole centrally through the fibula at the approximate level of the ankle joint as described by Peterson and associates (4). The free tendon graft was then routed through the fibular tunnel where it was isolated on both ends (Figure 8). While the foot was held in dorsiflexion and eversion, the tendon graft ends were then secured anteriorly and posteriorly to the previously drilled anchor slots via insertion of an interference screw at each location (Figure 9). For additional stability, the tendon was also sutured into the surrounding periosteum, and several pieces of morselized bone chips were packed into the fibular tunnel. At this point, approximately 15 mls of a platelet-rich plasma/thrombin complex were injected into both the anterior and posterior distal incision sites to augment postoperative healing (Figure 10).

Next, attention was directed back to the original incision site where the freed cut ends of the ATFL were mobilized and anastomosed in a pants-over-vest fashion (Figure 11). The inferior extensor retinaculum was then mobilized anteriorly and sutured into the capsule and periosteum of the lateral malleolus. A 2 x 4-cm dehydrated amniotic membrane graft was then laid over this repair site to promote postoperative healing and minimize the formation of scar tissue (Figure 12). All three surgical incision sites were then closed in layers while the foot was carefully held in dorsiflexion and eversion (Figure 13). A below-knee fiberglass cast was then applied with the foot held in this position.

The patient was maintained in the below-knee nonweightbearing cast for six weeks postoperatively, at which point he was transitioned to partial weightbearing in a fracture boot and physical therapy was initiated for 3 weeks. Three months following the procedure, the patient indicated no pain at the surgical site with good stability. He expressed sincere gratitude for the service performed, and he was instructed to continue progression back to a supportive athletic shoe (Figure 14).

Figure 1A. Preoperative MRI of previous Broström-Gould procedure. Note metal susceptibility artifact within the distal fibula; likely attributed to K-wire shards from prior surgery 1B and 1C. Note heterogenous signal intensity within the anterior-lateral gutter on axial imaging with ATFL not defined.

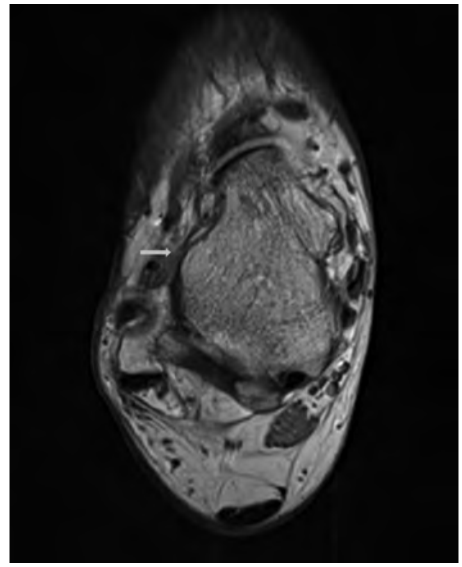

Figure 1B.

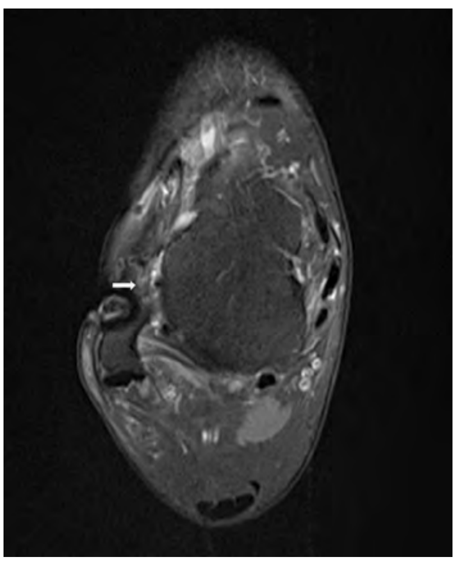

Figure 1C.

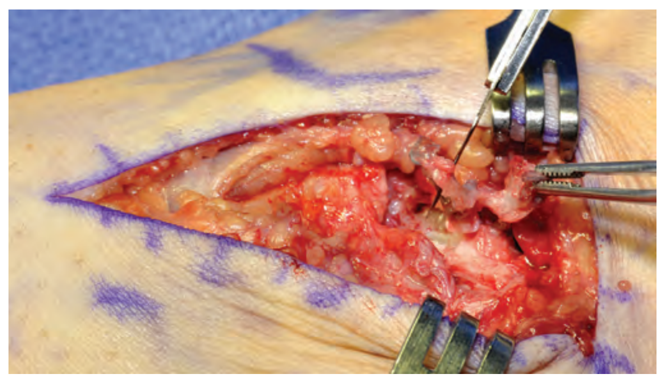

Figure 2. Strands of Fiberwire suture are carefully excised.

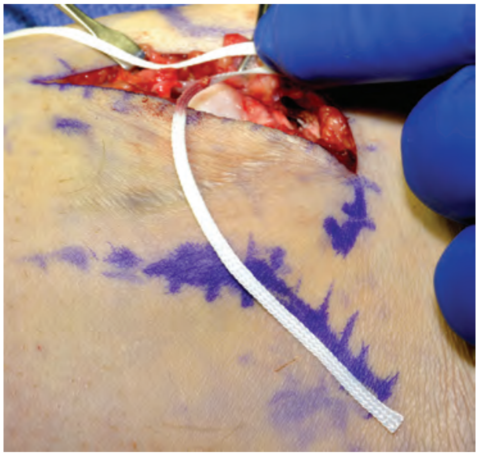

Figure 3. Umbilical tape directed anteriorly from lateral heel to determine approximate length of graft necessary. Anterior is at top of figure, proximal is at left.

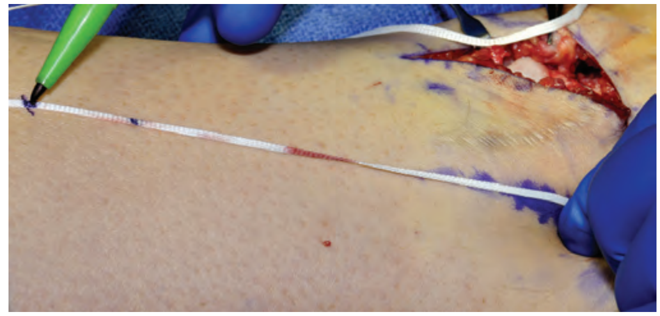

Figure 4. Tape is carried over the peroneal tendons proximally to demarcate sites for harvest of appropriate tendon length. Anterior is at top of figure, proximal is at left.

Figure 5A. Preparing to extract half the PL tendon. Incision placed through half the tendon longitudinally.

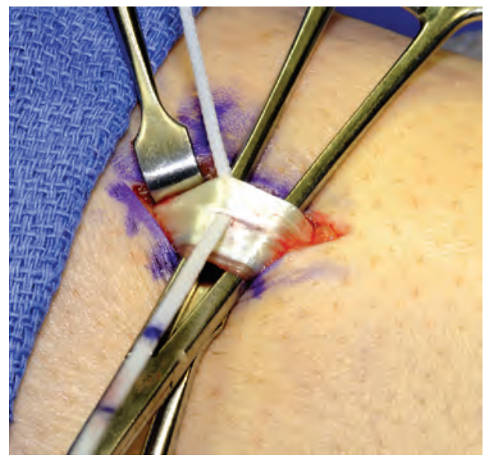

Figure 5B. Umbilical tape routed through anterior half of PL tendon.

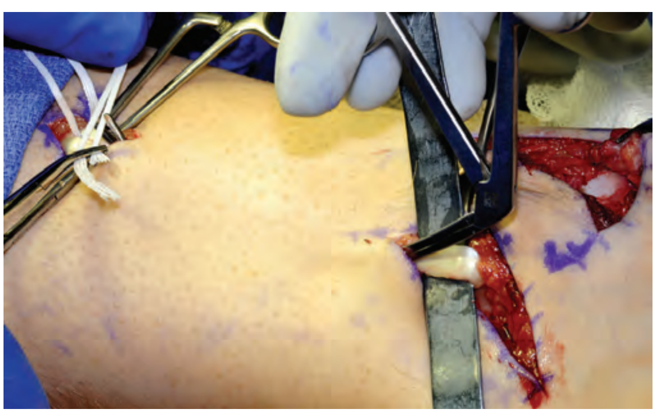

Figure 6. Tendon passer used to isolate half the PL for extraction. Anterior is at top of figure, proximal is at left.

Figure 7. Extracted tendon graft is isolated on both ends via absorbable suture.

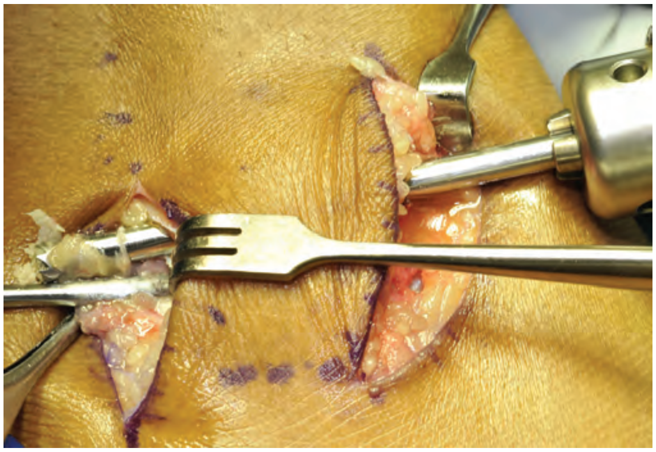

Figure 8A. Trephine used to bore tunnel at level of the ankle joint. Anterior is at top of figure, proximal is at left.

Figure 8B. Tendon routed through fibula. Anterior is at top of figure, proximal is at left.

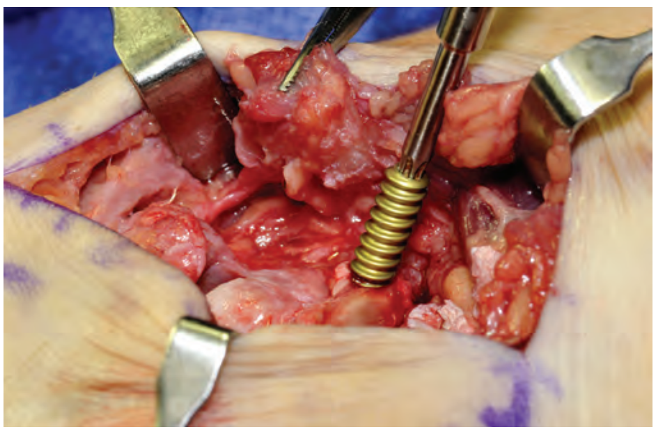

Figure 9. Application of an interference screw to secure the tendon ends. Anterior is at top of figure, proximal is at left.

Figure 10. Application of a platelet-rich plasma/autologous thrombin complex. Anterior is at top of figure, proximal is at left.

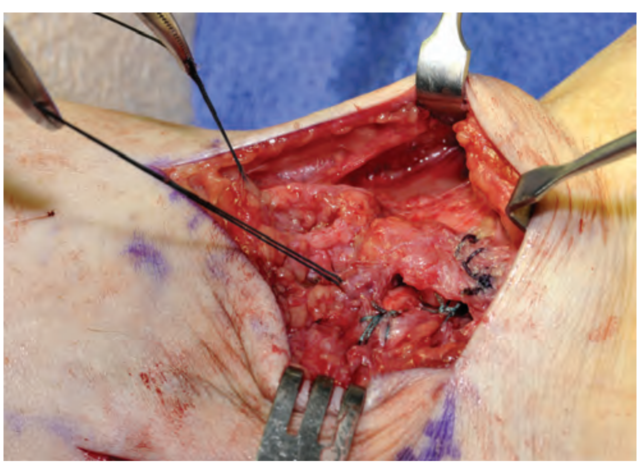

Figure 11. Repair of the previously-transected ATFL. Anterior is at top of figure, proximal is at left.

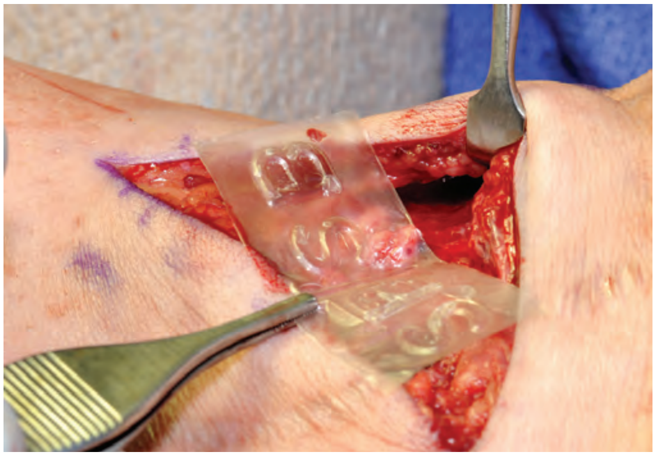

Figure 12A. Dehydrated amniotic membrane graft.

Figure 12B. Physiologic moisture within the surgical wound activates the graft and allows it to incorporate.

Figure 13. Incision sites postoperatively. Note old scar from original Broström procedure.

Figure 14. Three months postoperative. Note positioning of interference screws.

CASE 2

This patient was a 27-year old female veteran who presented with an approximately 6 year history of recurrent left lateral ankle pain and instability. Her symptoms began when she initially sprained her ankle during a long hike in basic training. She reported that she had subsequently gone on to have multiple reconstructive procedures including one that had "tied the tendons together." The patient had also previously failed multiple rounds of conservative therapy including a CAM walker, Arizona brace, and analgesic creams. She presented with complaints of multiple falls and instability, especially when maneuvering up or down stairs. She indicated that her condition was interfering with her ability to work, and expressed a desire to run and be active with her children again.

Upon physical examination, the patient exhibited severe laxity and tenderness to the left lateral ankle, with a positive talar tilt and anterior drawer sign (Figure 15). An MRI was reviewed, which indicated that the patient had previously undergone a Lee tenodesis procedure with probable scarring of the distal tendon loop as well as the remaining ATFL fibers (Figures 16, 17). Based on these findings, the decision was made to return to the operating room for revisional stabilization. As the patient in this case did not have a normal, functioning peroneus brevis tendon, it was determined again to reinforce the ankle with a split peroneus longus free tendon autograft. The procedure was performed in a similar manner as previously described. The patient was again maintained non-weightbearing in a below-knee cast for six weeks postoperatively, then transitioned to a CAM walker. As of the date of this publication, the patient continues to progress towards a satisfactory outcome.

Figure 15. Preoperative clinical examination. Note scar from original tenodesis stabilization.

Figure 16. Sagittal image on preoperative MRI. Note peroneus brevis tendon loop through distal fibula consistent with previous Lee procedure.

Figure 17A. Coronal views on preoperative MRI. Note sequential images on 17A and 17B demonstrating heterogenous signal intensity at the level of the distal fibula.

Figure 17B.

CONCLUSION

The combined lateral ankle-subtalar joint complex is composed of many structures susceptible to injury. When revisional surgery must be performed, it is important to determine the focus of instability as well as the integrity of the surrounding tendons and ligaments. Ideally, operative intervention should center on double-ligament repairs which reinforce the hindfoot as anatomically as possible using autogenous sources that minimize donor site morbidity. We believe that using free grafts of the split peroneus longus tendon can fulfill many of these goals.

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